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AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE CHEMISTRY

H

Higher Tier Paper 2

Wednesday 10 June 2020 Morning Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- a scientific calculator
- the periodic table (enclosed).

Instructions
- Use black ink or black ball-point pen.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

Information
- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

J U N 2 0 8 4 6 2 2 H 0 1

IB/M/Jun20/E12

8462/2H

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0 1 This question is about chemical analysis.

A student tested copper sulfate solution and calcium iodide solution using flame tests.

This is the method used.

1. Dip a metal wire in copper sulfate solution.
2. Put the metal wire in a blue Bunsen burner flame.
3. Record the flame colour produced.
4. Repeat steps 1 to 3 using the same metal wire but using calcium iodide solution.

0 1 . 1 What flame colour is produced by copper sulfate solution?

[1 mark]

The colour is green.

0 1 . 2 Calcium compounds produce an orange-red flame colour.

The student left out an important step before reusing the metal wire.

The student's method did **not** produce a distinct orange-red flame colour using calcium iodide solution.

Explain why.

[2 marks]

The student might not have cleaned the metal wire and thus copper sulfate solution is still present, therefore the colours are mixed.

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0 1 . 3 The student added sodium hydroxide solution to:

- copper sulfate solution
- calcium iodide solution.

Give the results of the tests.

[2 marks]

Copper sulfate solution A blue precipitate is formed.

Calcium iodide solution A White Precipitate is formed

0 1 . 4 To test for sulfate ions the student added dilute hydrochloric acid to copper sulfate solution.

Name the solution that would show the presence of sulfate ions when added to this mixture.

[1 mark]

Barium chloride solution

0 1 . 5 To test for iodide ions the student added dilute nitric acid to calcium iodide solution.

Name the solution that would show the presence of iodide ions when added to this mixture.

Give the result of the test.

[2 marks]

Solution A silver nitrate solution

Result A yellow precipitate is formed.

8

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0 2 This question is about water.

0 2 . 1 In the UK, potable (drinking) water is produced from different sources of fresh water.

Explain how potable water is produced from fresh water.

[4 marks]

Rain provides water with low levels of dissolved substances. This collects in the ground and in lakes or rivers. It is produced by choosing an appropriate source of fresh water. Passing the water through filter beds and then sterlising to kill any micro-organisms will be fresh to use.

0 2 . 2 A different country has:

- very little rainfall
- a long coastline
- plentiful energy supplies.

Suggest **one** process this country could use to obtain most of its potable water.

[1 mark]

- Distillation can be used for large quantities.
- The reverse osmosis process that use membranes, since only water molecules pass through.

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Do not write outside the box

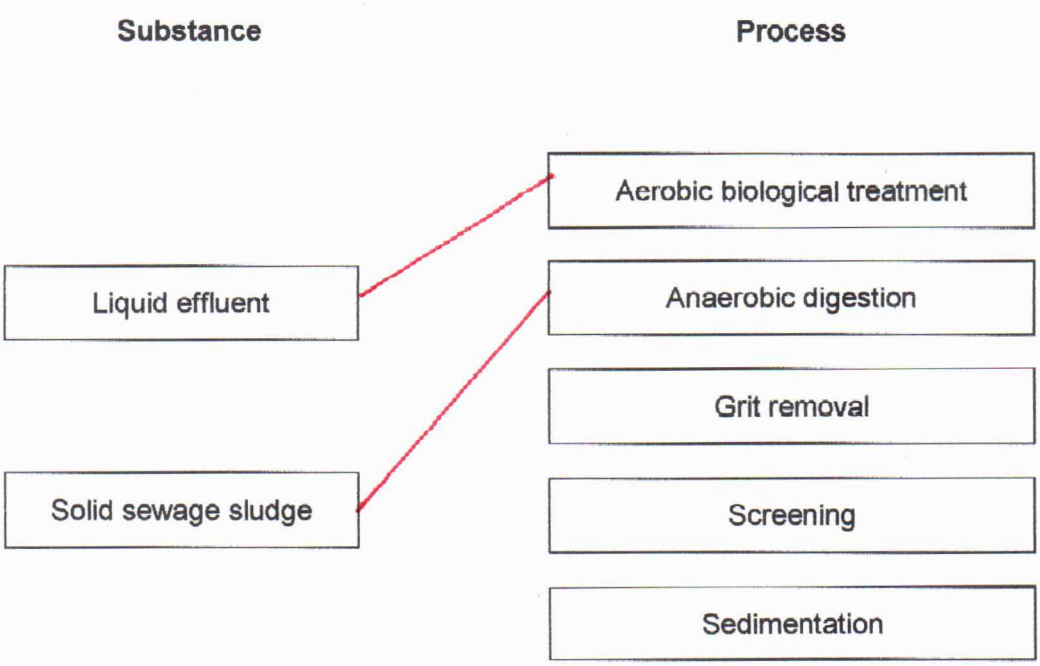
0 2 . 3 Waste water is not fit to drink.

Treatment of waste water produces two substances:

- liquid effluent
- solid sewage sludge.

Draw **one** line from each substance to the way the substance is processed.

[2 marks]



Question 2 continues on the next page

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Table 1 shows information about the disposal of processed solid sewage sludge in the UK in 1992 and in 2010.

Table 1

Year	Mass of processed solid sewage sludge in millions of kilograms				
	Used as fertiliser	Sent to landfill	Burned	Other methods	Total
1992	440	130	90	338	998
2010	1118	9	260	26	1413

0 2 . 4 Calculate the percentage of processed solid sewage sludge that was burned in 2010.

Give your answer to 3 significant figures.

Use **Table 1**.

[3 marks]

Percentage of Processed Sewage = $\frac{\text{burned waste}}{\text{total}} \times 100\%$

$= \frac{260}{1413} \times 100\%$

$= 18.4005667$

$= 18.4\%$

Percentage (3 significant figures) = 18.4 %

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Do not write outside the box

0 2 . 5 Suggest **one** reason why the total mass of processed solid sewage sludge increased between 1992 and 2010.

[1 mark]

The solid sewage Increased due to high Population and it might also be due to less Untreated sewage discharge.

0 2 . 6 Between 1992 and 2010 the proportion of processed solid sewage sludge used as fertiliser increased.

Suggest **two** reasons why.

[2 marks]

1 There has been Increased demand for food because of Increasing Population.

2 There has been Increased demand for organic fertilisers, leading to lifestyle choice of organic food.

13

Turn over for the next question

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0 3 This question is about hydrocarbons.

Hexane and hexene are hydrocarbons containing six carbon atoms in each molecule.

Hexane is an alkane and hexene is an alkene.

0 3 . 1 Draw **one** line from each hydrocarbon to the formula of that hydrocarbon.

[2 marks]

Alkanes formula C_nH_{2n+2}

Alkenes formula C_nH_{2n}

Hydrocarbon	Formula
Hexane	C_6H_{10}
Hexene	C_6H_{14}
	C_6H_8
	C_6H_{12}
	C_6H_{16}

0 3 . 2 Bromine water is added to hexane and to hexene.

What would be observed when bromine water is added to hexane and to hexene?

[2 marks]

Hexane There will be no change, the bromine water remains orange.

Hexene The orange bromine water turns to colourless.

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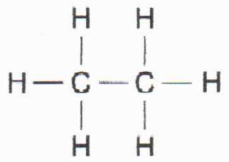
Do not write outside the box

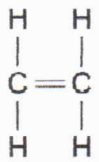
0 3 . 3 Ethane is an alkane and ethene is an alkene.

Figure 1 shows the displayed structural formulae of ethane and of ethene.

Figure 1



Ethane



Ethene

Compare ethane with ethene.

You should refer to:

- their structure and bonding
- their reactions.

[6 marks]

Ethane is a molecule with 6 hydrogen atoms and 2 carbon atoms and all are bonded with single Covalent bond (saturated hydrocarbon, while ethene has 4 hydrogen atoms and 2 carbon atoms in a double Covalent bond (Unsaturated hydrocarbons). Both of ethene and ethane react with oxygen in Complete combustion to produce Carbondioxide and Water. Incomplete combustion produces Carbon monoxide and Water, but is more likely in ethene. Ethene decolourises bromine water from Orange to Colourless) while in ethane no Colour change.

10

Turn over ▶

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0 4 This question is about ink.

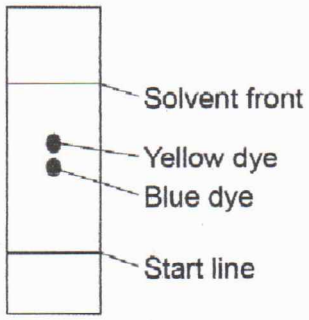
A student investigated green ink using paper chromatography in a beaker.

The student used water as the solvent.

Figure 2 shows the chromatogram obtained.

Figure 2

Diagram not to scale



0 4 . 1 The R_f value of the yellow dye = 0.60

The distance moved by the yellow dye = 5.7 cm

Calculate the distance moved by the solvent.

[3 marks]

Rf = distance travelled by substance / distance travelled by solvent.

$x \times 0.60 = \frac{5.7 \times x}{x}$

$\frac{0.60x}{0.60} = \frac{5.7}{0.60}$ $x = 9.5$ cm

Distance moved by the solvent = 9.5 cm

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Do not write outside the box

0 4 . 2 The green ink contains more than two compounds.

Suggest **one** reason why only two spots are seen on **Figure 2**.

[1 mark]

Some of the compounds were colourless in solution.

0 4 . 3 On the student's chromatogram, the yellow and blue spots are very close together.

Which **two** ways could increase the distance between the spots?

[2 marks]

Tick (✓) **two** boxes.

Allow the solvent front to travel further.	✓
Dry the chromatogram more slowly.	
Use a different solvent.	✓
Use a larger beaker.	
Use a larger spot of green ink.	

0 4 . 4 The manufacturers of the green ink always use the same proportions of yellow dye and blue dye.

Suggest **one** reason why.

[1 mark]

The green ink is a formulation.

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Do not write outside the box

0 4 . 5 The R_f value of a dye depends on:

- the solubility of the dye in the solvent
- the attraction of the dye to the paper.

Which will **definitely** produce a smaller R_f value if the solvent and paper are both changed?

[1 mark]

Tick (✓) **one** box.

The dye is less soluble in the new solvent and less attracted to the new paper.	
The dye is less soluble in the new solvent and more attracted to the new paper.	✓
The dye is more soluble in the new solvent and less attracted to the new paper.	
The dye is more soluble in the new solvent and more attracted to the new paper.	

8

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Do not write outside the box

0 5 This question is about materials used to make food plates.

Food plates are made from paper, polymers or ceramics.

Table 2 shows information about plates of the same diameter made from each of these materials.

Table 2

	Food plate material		
	Paper	**Polymers**	**Ceramics**
Raw material	Wood	Crude oil	Mined clay
Number packaged in 10 dm^3 cardboard box	500	100	50
Average number of times used	1	400	1000
Biodegradable?	Yes	No	No
Recyclable?	Yes	Yes	No

0 5 . 1 **Table 2** does **not** show information about energy usage.

Suggest **two** pieces of information about energy usage which would help to produce a complete life cycle assessment (LCA) for the three food plate materials.

[2 marks]

1 How to obtain the extraction of raw materials and Processing them.

2 Can the raw Materials used be reecycled, to enable cleaning the environment.

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Do not write outside the box

0 5 . 2 Evaluate the use of these materials for making food plates.

You should use features of life cycle assessments (LCAs).

Use **Table 2**.

[4 marks]

The raw Materials are trees which are renewable resources. Crude oil and clay are finite raw Materials.

The manufacturing and packaging of the paper plates use the least packaging so Conserve raw materials. Paper plates need less transportation overall as more plates in a $1 odm^3$ cardboard box.

The use and operation of Paper plates are single in use so must be replaced often. Ceramic plates last longer than the polymer plates.

Their disposal for polymer and Ceramic plates take up land fill which is running out. Paper and polymer plates can be reecycled to enhance Conservation of raw materials.

0 5 . 3 Describe how ceramic food plates are produced from clay.

[2 marks]

Ceramic food plates involves use of a wet clay that is shaped, then it is heated in a furnace for dryness.

8

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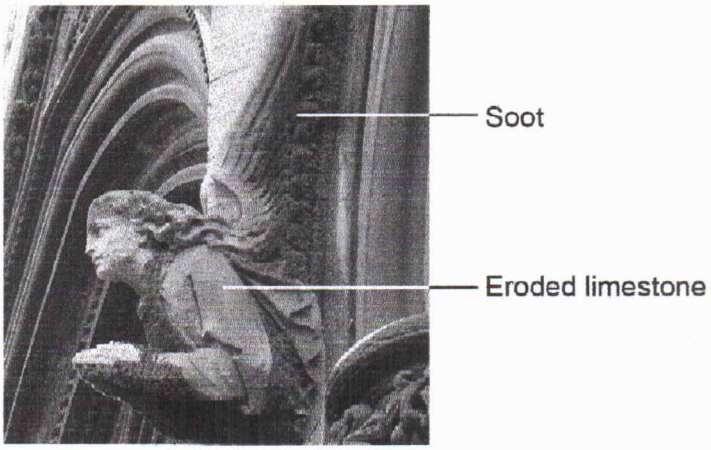
0 6 This question is about atmospheric pollution.

Figure 3 shows a limestone carving which has been damaged by atmospheric pollution.

The carving has been:

- blackened by soot
- eroded where the limestone has reacted with atmospheric pollutants.

Figure 3



0 6 . 1 Explain why soot is formed when some fossil fuels are burned.

[2 marks]

This happens due to the incomplete combustion as a result of insufficient supply of air (oxygen).

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Do not write outside the box

0 6 . 2 Fossil fuels are burned in car engines.

Explain how reducing the amount of sulfur in fossil fuels reduces the erosion of limestone.

[4 marks]

The sulfur reacts with oxygen to form sulfur dioxide.

$S_{(s)} + O_{2(g)} \longrightarrow SO_2$.

When less sulfur dioxide is emitted to the atmosphere and reacts with droplets of rain, it leads to acid rain, which results in limestone reacting with acid rain less.

0 6 . 3 Oxides of nitrogen are atmospheric pollutants which are formed in car engines.

Explain why oxides of nitrogen are formed in car engines.

[2 marks]

The car engines work at high temperatures. So in the engine, nitrogen from the air reacts with oxygen.

8

Turn over for the next question

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Do not write outside the box

0 7 This question is about carboxylic acids.

Carboxylic acids belong to a homologous series.

Table 3 shows information about the first three carboxylic acids in this homologous series.

Table 3

Name	Formula	pH of a 0.01 mol/dm^3 solution
Methanoic acid	HCOOH	2.91
Ethanoic acid	CH_3COOH	3.39
Propanoic acid	CH_3CH_2COOH	3.44

0 7 . 1 Complete **Table 3**.

[2 marks]

0 7 . 2 Ethanoic acid ionises in water.

The equation for the reaction is:

$$CH_3COOH(aq) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$$

Explain how the equation shows that ethanoic acid is a weak acid.

[2 marks]

Ethanoic acid is weak because it's ions dissociate partially or partial ionisation because the reaction is reversible.

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Do not write outside the box

0 7 . 3 A student adds a solution of ethanoic acid to zinc carbonate in an open flask on a balance.

Explain what happens to the mass of the flask and its contents during the reaction.

[3 marks]

When zinc carbonate reacts with ethanoic acid the mass of the flask and contents decreases because of the production of carbon dioxide and the gas produced escapes from the flask.

0 7 . 4 The student compares the rates of the reaction of zinc carbonate with:

- 0.01 mol/dm^3 methanoic acid
- 0.01 mol/dm^3 ethanoic acid.

The rate of the reaction with methanoic acid is greater than the rate of the reaction with ethanoic acid.

Explain why.

You should refer to ions in your answer.

Use **Table 3**.

[3 marks]

0.01 Mol/dm^3 of Methanoic acid has a lower PH and so Methanoic acid has a higher Concentration of hydrogen ions, therefore More Collisions per unit time.

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Do not write outside the box

Ethanoic acid reacts with ethanol to produce an ester.

0 7 . 5 Give the name of the ester produced when ethanoic acid reacts with ethanol.

[1 mark]

ethyl ethanoate.

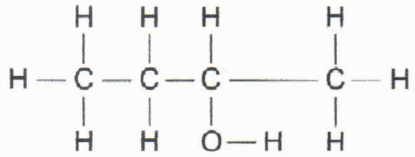
0 7 . 6 Hexanedioic acid and ethanediol join together to produce a polyester.

Ethanoic acid and ethanol join together in the same way to produce an ester.

Which is the displayed structural formula of the ester produced when ethanoic acid reacts with ethanol?

[1 mark]

Tick (✓) **one** box.



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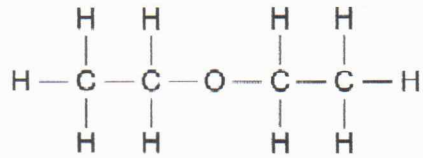

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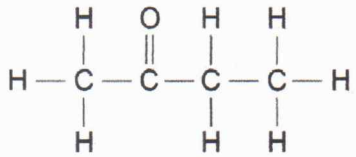

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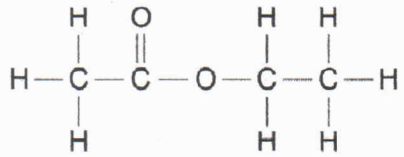

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12

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0 8 This question is about the rate of the reaction between hydrochloric acid and calcium carbonate.

A student investigated the effect of changing the size of calcium carbonate lumps on the rate of this reaction.

This is the method used.

1. Pour 40 cm^3 of hydrochloric acid into a conical flask.
2. Add 10.0 g of small calcium carbonate lumps to the conical flask.
3. Attach a gas syringe to the conical flask.
4. Measure the volume of gas produced every 30 seconds for 180 seconds.
5. Repeat steps 1 to 4 using 10.0 g of large calcium carbonate lumps.

The student calculated the number of moles of gas from each volume of gas measured.

Table 4 shows the student's results for large calcium carbonate lumps.

Table 4

Time in seconds	Number of moles of gas
0	0.0000
30	0.0011
60	0.0020
90	0.0028
120	0.0034
150	0.0038
180	0.0040

The student plotted the results for small calcium carbonate lumps on **Figure 4**.

0 8 . 1 Complete **Figure 4**.

You should:

- plot the data for large calcium carbonate lumps from **Table 4**
- draw a line of best fit.

[3 marks]

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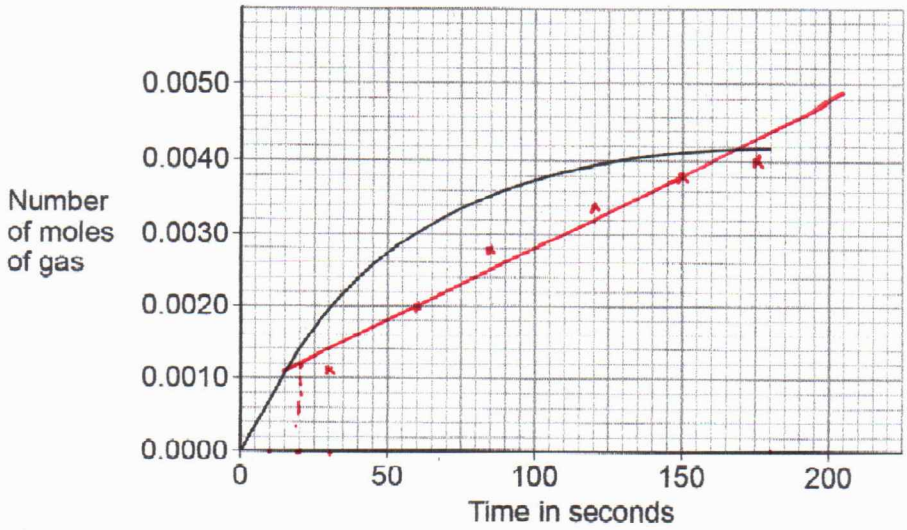
Figure 4



0 8 . 2 Determine the mean rate of reaction for **small** calcium carbonate lumps between 20 seconds and 105 seconds.

Give the unit.

Use **Figure 4**.

[4 marks]

Mean rate $= \frac{0.0038 - 0.0014}{105 - 20}$

$= \frac{0.0024}{85}$

$= 0.0000282$

$\approx 2.8 \times 10^{-5}$ mol/s

Mean rate of reaction = 2.8×10^{-5} Unit mol/s

0 8 . 3 The student concluded that the large calcium carbonate lumps reacted more slowly than the small calcium carbonate lumps.

How do the student's results show that this conclusion is correct?

[1 mark]

For the large lumps, smaller number of moles of gas is collected.

Turn over ▶

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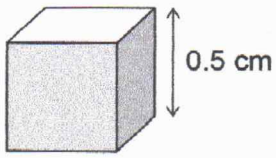
Do not write outside the box

The difference in the rates of reaction of large lumps and of small lumps of calcium carbonate depends on the surface area to volume ratios of the lumps.

Figure 5 shows a cube of calcium carbonate.

Figure 5



0 8 . 4 Calculate the surface area to volume ratio of the cube in **Figure 5**.

Give your answer as the simplest whole number ratio.

[3 marks]

Surface area = (0.5 × 0.5) × 6 faces of cube

= 1.5 cm^2

Volume = 0.5 × 0.5 × 0.5

= 0.125 cm^3

Surface area : Volume

$\frac{1.5\ cm^2}{0.125} : \frac{0.125\ cm^3}{0.125}$

12 : 1

Surface area : volume = 12 : 1

0 8 . 5 A larger cube of calcium carbonate has sides of 5 cm

Describe how the surface area to volume ratio of this larger cube differs from that of the cube shown in **Figure 5**.

[1 mark]

The surface area to volume ratio decreases by a factor of 10.

12

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0 9 This question is about algae.

A student:

- placed algae in water containing dissolved carbon dioxide
- shone bright light on the algae.

Gas bubbles were collected as the algae photosynthesised.

0 9 . 1 Describe a test that would identify the gas collected.

Give the result of the test.

[2 marks]

Test Use a glowing splint and Put in the test tube.

Result It will relight If oxygen is present.

0 9 . 2 Glucose is produced when algae photosynthesise.

Name **two** naturally occurring polymers produced from glucose.

[2 marks]

Starch and Cellulose

Question 9 continues on the next page

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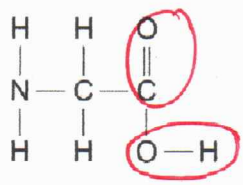
Figure 6 shows the displayed structural formula of an amino acid called glycine.

Figure 6



Carboxylic group
alcohol group.

0 9 . 3 How many functional groups are there in the molecule in **Figure 6**?

[1 mark]

Tick (✓) **one** box.

1 ☐ 2 ☑ 3 ☐ 4 ☐

0 9 . 4 Glycine reacts by condensation polymerisation to produce a polypeptide and one other substance.

Name the other substance produced.

[1 mark]

Water

0 9 . 5 Scientists think that algae may have used gases in Earth's early atmosphere.

Algae need an element to produce the molecule in **Figure 6** which is **not** present in water or carbon dioxide.

Which **two** gases from Earth's early atmosphere could have provided this element?

[2 marks]

ammonia and nitrogen

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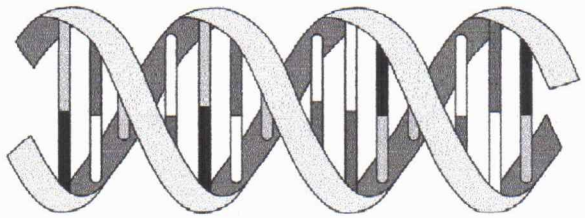
Do not write outside the box

0 9 . 6 The development and function of algae are controlled by a naturally occurring polymer.

Figure 7 represents the shape and structure of this polymer.

Figure 7



Describe the shape and structure of this polymer.

[3 marks]

The polymer has two chains (two polymer strands with four different bases (nucleotides) which are the Monomers. They include cytosine, guanine, adenine and thymine. They form a double helix and are complementary to each other.

11

Turn over for the next question

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Do not write outside the box

10 This question is about a reversible reaction.

The reaction between solutions of iron(III) ions (Fe^{3+}) and thiocyanate ions (SCN^-) is reversible.

The ionic equation for the reaction is:

	$Fe^{3+}(aq)$	+	$SCN^-(aq)$	⇌	$FeSCN^{2+}(aq)$
Colour of solution:	yellow		colourless		red

The colour of the equilibrium mixture is orange at room temperature.

10.1 Give the name of the solvent used to dissolve the ions in this reaction.

[1 mark]

Water

10.2 A few drops of a colourless solution containing a high concentration of thiocyanate ions (SCN^-) are added to the orange equilibrium mixture.

Explain the colour change observed.

[3 marks]

The colour changes to more red, this is because the position of equilibrium moves to the right, so that the increase in the concentration of thiocyanate ions is reduced.

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Do not write outside the box

10.3 A water bath is set up at a temperature above room temperature.

When a test tube containing the orange equilibrium mixture is placed in the water bath, the mixture becomes more yellow.

Explain what this shows about the energy change for the forward reaction.

[3 marks]

The position of equilibrium moves to the left and the increase in the temperature is reduced, therefore the forward reaction is exothermic.

10.4 Explain why a change in pressure does **not** affect the colour of the equilibrium mixture.

[2 marks]

The change in pressure doesn't affect since the position of equilibrium will not change and no gases are present. The only solutions present are aqueous.

10.5 Other metal ions form coloured equilibrium mixtures with thiocyanate ions.

Which metal ion could form a coloured equilibrium mixture with thiocyanate ions?

[1 mark]

Tick (✓) **one** box.

- Al^{3+} ☐
- Co^{2+} ☑
- Mg^{2+} ☐
- Na^{+} ☐

10

END OF QUESTIONS